

What is claimed is:

1            1. A control system for an automotive  
2 vehicle having a vehicle body comprising:

3            a first angular rate sensor generating a first  
4 angular rate signal corresponding to a first angular  
5 motion of the vehicle body;

6            a second angular rate sensor generating a  
7 second angular rate signal corresponding to a second  
8 angular motion of the vehicle body;

9            a lateral accelerometer generating a lateral  
10 acceleration signal corresponding to a lateral  
11 acceleration of a center of gravity of the vehicle body;

12           a longitudinal accelerometer generating a  
13 longitudinal acceleration signal corresponding to the  
14 longitudinal acceleration of the center of gravity of  
15 the vehicle body;

16           a wheel speed sensor generating a wheel speed  
17 signal corresponding to a wheel speed of the vehicle;  
18 and

19           a controller coupled to said first angular  
20 rate sensor, said second angular rate sensor, said  
21 lateral accelerometer, said longitudinal accelerometer,  
22 and said wheel speed sensor, said controller determining  
23 a global roll attitude and a global pitch attitude from  
24 the first angular rate signal, and the second angular  
25 rate signal, lateral acceleration signal and the  
26 longitudinal acceleration signal, said controller  
27 determining a roll gradient based upon a past raw roll  
28 rate and current raw roll rate, the first angular rate  
29 signal or the second angular rate signal and the lateral  
30 acceleration signal, a pitch gradient based upon a past  
31 raw pitch rate and current raw pitch rate the first or

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32 second angular rate signal and the longitudinal  
33 acceleration signal, determining a relative roll and  
34 relative pitch as a function of the roll gradient and  
35 the pitch gradient.

1 2. A system as recited in claim 1 wherein  
2 said first angular rate sensor is one selected from the  
3 group of a yaw rate sensor, a pitch rate sensor and a  
4 roll rate sensor and said second angular rate sensor  
5 comprises is one selected from the group of a yaw rate  
6 sensor, a pitch rate sensor and a roll rate sensor, said  
7 second sensor being different than the first sensor.

1 3. A control system for an automotive  
2 vehicle having a vehicle body comprising:

3 a roll angular rate sensor generating a roll  
4 angular rate signal corresponding to an roll angular  
5 motion of the vehicle body;

6 a yaw angular rate sensor generating a yaw  
7 motion signal corresponding to a yaw motion of the  
8 vehicle body;

9 a lateral accelerometer generating a lateral  
10 acceleration signal corresponding to a lateral  
11 acceleration of a center of gravity of the vehicle body;

12 a longitudinal accelerometer generating a  
13 longitudinal acceleration signal corresponding to the  
14 longitudinal acceleration of the center of gravity of  
15 the vehicle body;

16 a wheel speed sensor generating a wheel speed  
17 signal corresponding to a wheel speed of the vehicle;  
18 and

19 a controller coupled to said roll angular rate  
20 sensor, said yaw angular rate sensor, said lateral

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21 accelerometer, said longitudinal accelerometer, and said  
22 wheel speed sensor, said controller determining a global  
23 roll attitude and a global pitch attitude from the roll  
24 rate, lateral acceleration signal and the longitudinal  
25 acceleration signal, determining a pitch rate in  
26 response to said first angular rate signal, said second  
27 angular rate signal, said lateral acceleration signal,  
28 said longitudinal acceleration signal, and said wheel  
29 speed signal, said controller determining a roll  
30 gradient based upon a past raw roll rate and current raw  
31 roll rate, the roll angular rate signal and the lateral  
32 acceleration signal; a pitch gradient based upon a past  
33 raw pitch rate and current raw pitch rate the calculated  
34 pitch angular rate signal and the longitudinal  
35 acceleration signal, determining a relative roll and  
36 relative pitch as a function of the roll gradient and  
37 the pitch gradient.

1 4. A control system as recited in claim 3  
2 further comprising a safety system coupled to said  
3 controller, said controller generating a control signal  
4 to said safety system in response to said the relative  
5 roll angle, the relative pitch angle, the global roll  
6 and the global pitch angle.

1 5. A control system as recited in claim 4  
2 wherein said safety system comprises an active brake  
3 control system.

1 6. A control system as recited in claim 4  
2 wherein said safety system comprises an active rear  
3 steering system.

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1           7. A control system as recited in claim 4  
2 wherein said safety system comprises an active front  
3 steering system.

1           8. A control system as recited in claim 4  
2 wherein said safety system comprises an active anti-roll  
3 bar system.

1           9. A control system as recited in claim 4  
2 wherein said safety system comprises an active  
3 suspension system.

1           10. A method of controlling a rollover system  
2 for a vehicle body of an automotive vehicle comprising:  
3           measuring a roll rate of the vehicle body;  
4           measuring a lateral acceleration of the  
5 vehicle body;  
6           measuring a longitudinal acceleration of the  
7 vehicle body;  
8           measuring a yaw rate of the vehicle body;  
9           determining a calculated pitch rate signal  
10 from the yaw rate, the roll rate, the lateral  
11 acceleration and the longitudinal acceleration;  
12           determining a global roll attitude and a  
13 global pitch attitude from the calculated pitch angular  
14 rate, the roll rate, lateral acceleration and the  
15 longitudinal acceleration;  
16           determining a roll gradient based upon a past  
17 raw roll rate, the roll rate signal and the lateral  
18 acceleration signal;  
19           determining a relative roll angle based upon  
20 said roll gradient;

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21                   determining a pitch gradient based upon a past  
22   raw pitch rate and calculated pitch rate and the  
23   longitudinal acceleration signal;

24                   determining a relative pitch angle based upon  
25   said pitch gradient; and

26                   activating a safety device in response to the  
27   relative roll angle, the relative pitch angle, the  
28   global roll and global pitch angle.

29                   11. A method as recited in claim 10 wherein  
30   determining a relative pitch angle comprises determining  
31   a relative pitch angle using an Euler approximation.

1                   12. A method as recited in claim 10 wherein  
2   determining a relative roll angle comprises determining  
3   a relative roll angle using an Euler approximation.

1                   13. A method as recited in claim 10 wherein  
2   said step of activating a safety device comprises one  
3   selected from the group consisting of an active brake  
4   control system, an active rear steering system, an  
5   active front steering system, an active anti-roll bar  
6   system, and an active suspension system.

1                   14. A method of controlling a safety system  
2   for a vehicle body of an automotive vehicle comprising:

3                   measuring a roll rate of the vehicle body;

4                   measuring a lateral acceleration of the  
5   vehicle body;

6                   measuring a longitudinal acceleration of the  
7   vehicle body;

8                   measuring a yaw rate of the vehicle body; and

9 determining relative roll angle, ~~the~~ relative  
10 pitch angle, ~~the~~ global roll and global pitch angle in  
11 response to the roll rate, the yaw rate, the lateral  
12 acceleration and the longitudinal acceleration.

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